# Problem Solving

## Introduction

The task of solving problems will consume a great deal of your time and energy as a commissioned officer and a manager. Although some people seem to have a special talent for assessing problems and devising solutions, the problem-solving process can be learned and a person's existing skills in this area can be improved through a systematic approach.

## Study Assignment

Read the information section of this lesson.

Lesson Objective: Comprehend the six-step problem solving process.

Samples of Behavior:
1. Explain the six-step problem-solving process.
2. Given a scenario, identify the steps in the problem-solving process.
3. Identify four ways of classifying data.
4. Identify examples of the four barriers to creativity.
5. Explain the four rules of brainstorming.
6. Explain the six basic measurement tools (flowchart, cause and effect diagram, Pareto chart, scatter diagram, histogram, and run chart.)

## Information

### Six-Step Problem-Solving Process

A problem can be a question raised for inquiry, consideration, or solution; an unsettled question; or a source of perplexity or vexation. There's nothing inherently difficult about solving problems. Sure, some problems are more difficult to solve than others, but this is because some problems are more complex than others. It isn't because the problems themselves resist being solved.

***THE SIX STEPS OF THE PROBLEM-SOLVING PROCESS***

1. Recognize the problem.
2. Gather data relative to the problem.
3. List possible solutions to the problem.
4. Test possible solutions to the problem.
5. Select the best solution to the problem.
6. Implement the problem solution.

# Recognize the Problem

This first step in problem solving, **identifying the problem**, is so critical that it's the first step in ALL recognized techniques of problem solving. To identify the problem incorrectly and then "spin your wheels" working on a solution to the WRONG problem is probably the greatest sin of problem solving. It's imperative to analyze the **total problem environment**. The ease with which you can apply the steps of the problem-solving sequence will be determined, to a great extent, by your thoroughness in analyzing the **elements of the problem environment**.

The total problem environment consists of three parts:

1. An individual
2. An obstacle
3. A goal

In order to assemble the data necessary for the correct identification of the problem, you must analyze and interpret the relationship of these three parts. For example:

> From the base semiannual expense account, the support group commander has determined the cost of power mower maintenance for the first 6 months of the current fiscal year is 40 percent higher than the cost of mower maintenance for the first 6 months of the previous fiscal year. The commander has directed the chief of Civil Engineering (CE) to cut the cost of mower maintenance to a level that will ensure this year's total maintenance cost won't exceed last year's total cost.

In the above scenario there isn't enough data available to even tentatively identify the problem. Why? Because one of the elements of the problem environment is missing. There's no **obstacle** -- we don't know the obstacle. What's interfering with goal accomplishment? Suppose an investigation of the mower maintenance costs determine the following: *The equipment is experiencing more MAJOR breakdowns this year than last year.* Although some operators are abusing the equipment, this is only one of the causes of the breakdowns. Parts from suppliers have increased significantly in cost. CE can now identify the obstacle as being more major breakdowns of equipment (caused by a variety of reasons) and the increased costs associated with these breakdowns.

The problem can then be identified as one of reducing major breakdowns. Once CE has identified the problem, make a statement of the problem. This statement must be prepared in one of three ways:

- As a question: "How can we . . .?"
- As a statement of need: "We need to . . ."
- As an infinitive phrase: "To find a way to . . ."

To state a problem in one of these ways is a part of the systematic approach to problem solving. Any of these three statements will serve as a guide for your research in the "GATHER DATA" phase to come.

## Gathering Data Relative to the Problem

The data that the problem solution requires may be classified as:

1. **Facts**
2. **Criteria**
3. **Assumptions**
4. **Definitions**

1. **Facts** - are truths upon which your solution to the problem is based. They're observed events, past or present.

2. **Criteria** - are limits within which your solution to the problem must fall.

3. **Assumptions** - are statements that may or may not be true, but have some bearing upon the situation at hand.

4. **Definitions** - are used to explain words or terminology that might be unfamiliar to a third party.

The most available source of factual data will normally be your own experience. Criteria may be provided by a superior, be inherent in the nature of the obstacle causing the problem, or, as is more common, inherent in the problem-solvers own frame of reference and in the goal he/she's trying to attain. This goal and this frame of reference will tolerate only certain solutions, and the limits of this tolerance will establish the criteria for the solution.

During the data-gathering step there'll be times when you accumulate some opinions that are of limited value in reaching a solution to a problem. Solutions must be based on <u>facts</u> -- the only form of data that's demonstrably true. Opinions or assumptions don't meet this test. As you gather data to be used in support of a solution, you'll be required to evaluate each item to determine if it's a fact or opinion.

Remember:

- A fact is an observed event, past or present, you've observed or that's been observed and reported to you.

- An opinion or assumption is a judgment you or some other individual has made.

## Tools for Process Analysis

Flowcharts and cause-and-effect diagrams are excellent analysis tools. You can also use thematic content analysis or a Pareto chart in your analysis efforts. Here's a quick look at tools for analyzing problems:

- Flowchart: Want to see what a process looks like from start to finish? A flowchart is a graphical representation of all major steps of a process. To understand the complete process, identify critical stages within a process, and locate problem areas. Flowcharts also show relationships between different steps in the process. Here's what to do:

  1. *Identify the process.* First, define start and finish points for the process being examined.

  2. *Describe the current process.* From the starting point, chart the entire process. Work slowly and include every step along the way, right through to the finish. Use standard flowchart symbols to improve the clarity of the flowchart, but they're not essential.

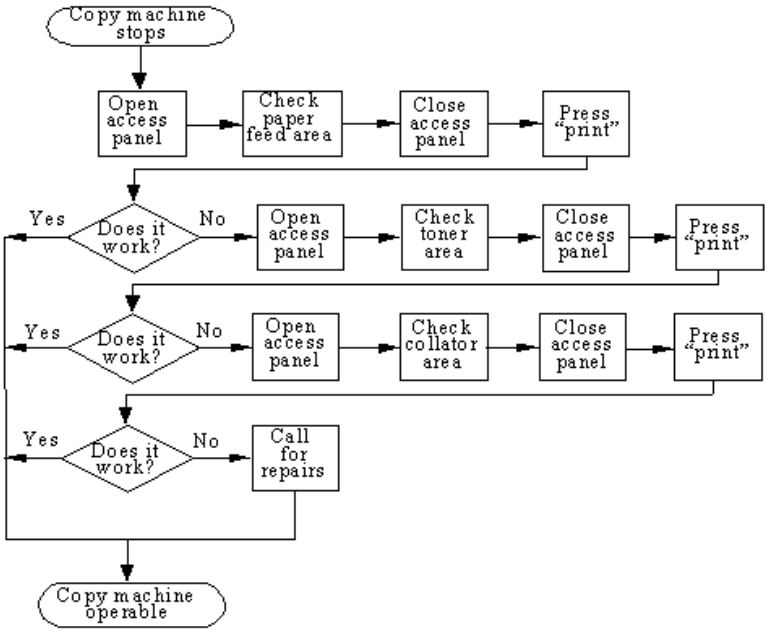
  3. *Chart the ideal process* (this is an optional step). Try to identify the easiest and most efficient way to go from the "start" to “finish.” This flowchart makes it easier to find improvements.

  4. *Search for improvement opportunities.* Study the flowchart. The process probably has areas that hinder or add little or no value. Look at the flowchart, and examine any steps that differ from the ideal process, and question why they exist.

  5. *Update the chart.* Build a new flowchart that corrects the problems identified.

When working on the flowchart, consider using index cards or sticky-back notes to record each step of the process. Then rearrange the diagram without erasing and redrawing. This can reduce the chances of losing valuable ideas.

Example: A copy machine suffered frequent paper jams, and was a notorious source of frustration. Often, simply opening and closing the access panel clears the problem. Here's a flow chart of the troubleshooting procedure most people used:




Users usually had to check several locations in the copy machine before they found the problem. An office worker posted this flowchart showing a more efficient procedure. This process reduced frustration and "panel slamming" when the machine stopped unexpectedly.

- Cause and Effect Diagram: To examine the relationship between a given outcome and the factors influencing that outcome, use a cause-and-effect diagram. Sometimes called an Ishikawa diagram or even a "fishbone diagram," the cause-and-effect diagram focuses on specific issues, identifies areas short on data and gives you a structured approach to finding root causes. Here's what to do:

  1. *Specify the problem to analyze.* The effect can be stated positively (in terms of the objective to be accomplished) or negatively (in terms of a problem to be overcome). Place the problem's title in a box on the right side of the diagram.

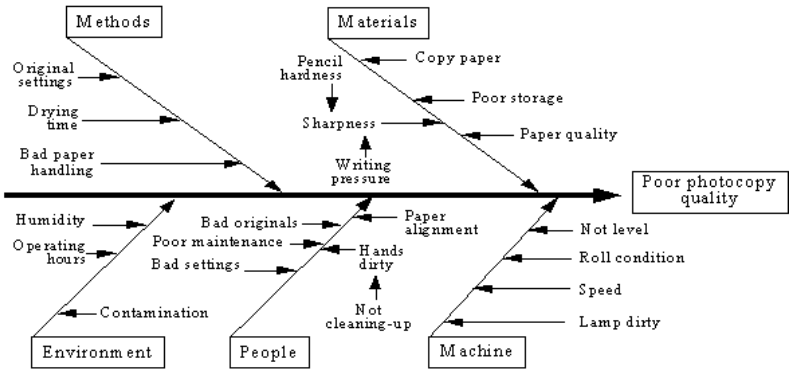
  2. *List the major categories of factors influencing the effect being studied.* Use the "4Ms" (methods/manpower/ materials/ machinery) or "4 Ps" (policies/procedures/people/plant) as the starting point.

  3. *Identify factors and subfactors.* Ask "Why?" or use brainstorming or mental imaging to generate ideas. Start with the major categories and work from there.

  4. *Identify significant factors.* List the factors having a significant effect (data can help identify these).

5. *Prioritize the list of causes.* Don't confuse the location of ideas with importance -- a subfactor may be the root cause to all the problems. After prioritizing new factors may be discovered then more data should be collected.

Example: The frustrated office workers put their heads together and identified specific issues in their search for the root cause. Take a look:




- Pareto Chart: Pareto charts are bar charts based on the Pareto Principle: 20 percent of the problems have 80 percent of the impact. Those 20 percent are the "vital few." Separating the problems or issues in this way helps you focus on the improvement process. Why? A Pareto chart allows you to arrange data according to priority or importance. This takes the guesswork out of the process. Here's what to do:

  1. *Identify the possible problems.* To generate ideas use brainstorming, mental imaging or ask "Why?". List all the possible problems in a particular process.

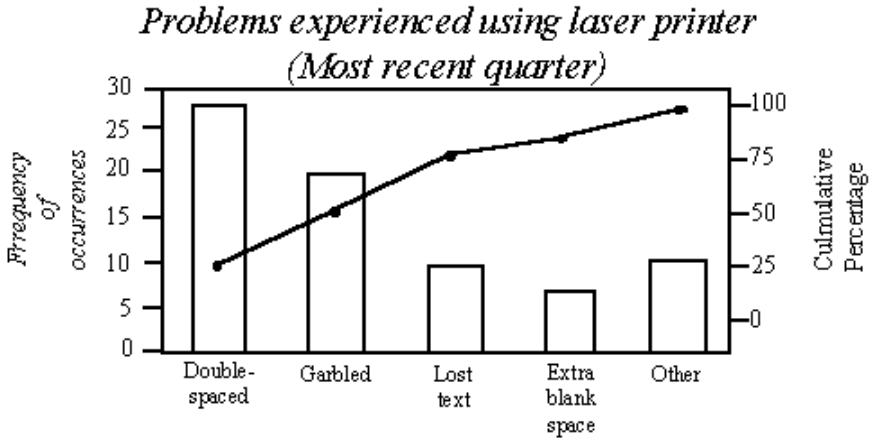
  2. *Use existing reports or collect new data on the process.* Group existing data by consistent units of measure. That means dollars, percentages, pounds, etc.

  3. *Label the chart.* Put frequency of occurrence on the left vertical axis and categories of problems on the horizontal axis.

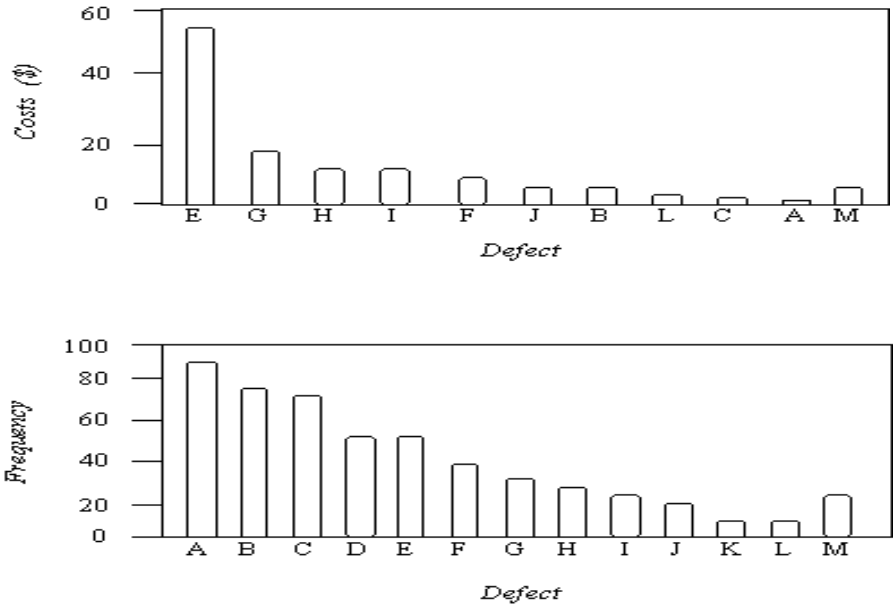
  4. *Plot the data.* Order the categories according to their frequency (how many), not their classification (what kind). Use a descending order from left to right. If there are stray categories, include an "other" category.

Here's an optional step: use the right vertical axis to measure the cumulative percentage of total occurrences summed over all the categories.

Example: The office staff experienced a lot of trouble with a new laser printer. This Pareto chart helped them identify the "vital few" problems. The left side shows the frequency of occurrences; the actual problems are listed along the bottom:




Next is a comparison of frequency and cost. The most common defect is "A." The most costly defect, though, is "E." Take a look:




## Tools for Analysis of Process Data

The histogram, scatter diagram, and run chart are excellent tools to use to analyze process data. Here is a quick look at these tools:

- Histogram: To show the central tendency and variability of a data set use a graph called a histogram -- sometimes referred to as a frequency distribution. A histogram can help you determine the underlying distribution of a process. Histograms also help understand the total variability of a process. When using histograms, each data point appears in only one interval. The number of intervals can influence the pattern the data will take. Don't expect histograms to be a perfect bell curve; expect variations. Here's what to do:

1. *Determine the type of data to collect.* Make sure the data are measurable. Times, lengths and speeds are examples of measurable data.

2. *Collect the data.* Obtain a random sample of data from the process. Collect as many measurable points as possible. Then count the total number of points collected.

3. *Determine the number of intervals required.* Use this guide to determine how many intervals (or bars) the graph should have.

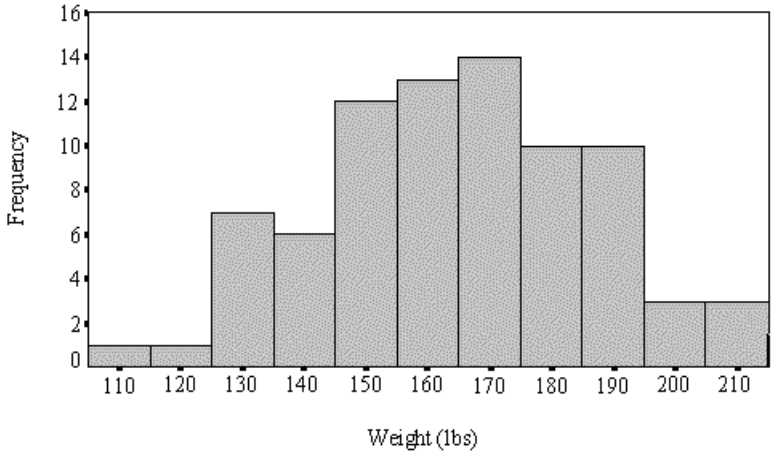
4. *Determine the range.* Study the data set. Subtract the smallest value from the largest. This value is the range of the data set.

5. *Determine the interval width.* Divide the range by the number of intervals. Round answers up to a convenient value. For example, if the range of the data is 17 and 9 intervals are used, then the interval width is 1.88. Round this interval to 2.0. It's a good idea to carry the intervals to one decimal place more than the data collected.

6. *Determine the starting point of each interval.* Use the smallest data point value as the starting point of the first interval. The starting point for the second interval is the sum of the smallest data point plus the interval width. For example, if the smallest data point is 10 and the interval width is 2, then the starting point for the second interval is 12. Label intervals along the horizontal axis.

7. *Plot the data.* Count the number of data points that fall within each interval; plot this frequency on the histogram. Remember: each data point can appear in just one interval. For example, if the first interval begins with 10.0 and the second with 12.0, then all data points that are equal to or greater than 10.0 and still less than 12.0 are counted in the first interval.

Example: During aerobic testing, evaluators weighed 80 Air Force officers. Here's a histogram and a table showing the distribution of the data. Which format is most useful?



*Weights of 80 officers*

| | | | | |
|---|---|---|---|---|
| 208 | 180 | 139 | 163 | 159 |
| 155 | 180 | 165 | 149 | 127 |
| 159 | 171 | 141 | 190 | 159 |
| 153 | 181 | 180 | 137 | 161 |
| 115 | 156 | 173 | 165 | 191 |
| 159 | 109 | 179 | 145 | 144 |
| 150 | 206 | 166 | 188 | 165 |
| 127 | 130 | 172 | 180 | 147 |
| 145 | 150 | 156 | 171 | 189 |
| 190 | 200 | 208 | 169 | 139 |
| 130 | 128 | 155 | 185 | 166 |
| 165 | 187 | 159 | 178 | 169 |
| 147 | 150 | 201 | 128 | 170 |
| 189 | 163 | 150 | 158 | 180 |
| 139 | 149 | 185 | 129 | 169 |
| 175 | 189 | 150 | 201 | 175 |

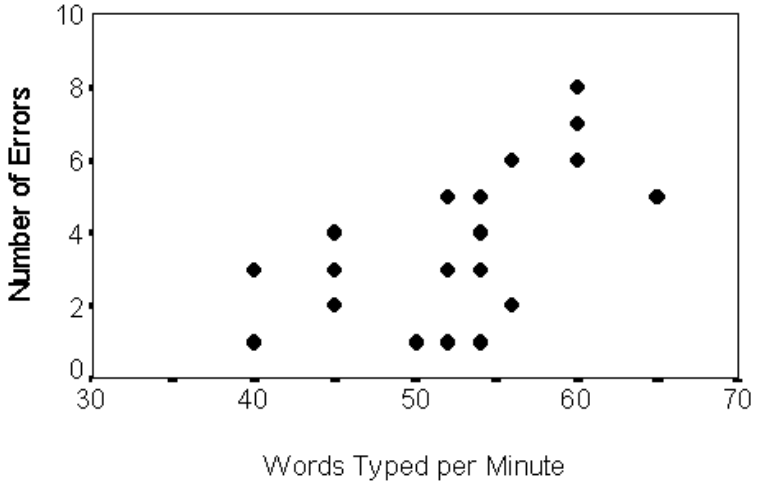
- Scatter Diagram: Recognize the relationship between two variables with a scatter diagram. These diagrams are graphs that reveal possible relationships and also help identify possible causes of problems. An important note: while this method shows a relationship exists, it won't show that one variable causes another. Further analysis using other statistical techniques will quantify the strength of a relationship between two variables. Remember, that when a relationship exists between two variables, they're correlated. (Both positive and negative correlation can be useful for continuous process improvement.) Here's what to do:

  1. *Collect the data in pairs.* Find two different variables (X and Y) that appear to have a relationship. Each point on the scatter diagram is an (X, Y) pair of values. There will be many (X, Y) data points on one scatter diagram.

  2. *Construct the graph.* Label the horizontal and vertical axes in ascending order. Make sure the value on the two axes correspond to the data pairs.

  3. *Plot the data.* Look for patterns when plotting each point, circling repeated points. Here's an illustration to help you interpret scatter diagrams.

Example: A typing agency wanted to investigate the relationship of speed of typing and errors made.



Observations about the Scatter Diagram -- One person typed 65 words per minute with 5 mistakes. One person typed 40 words per minute with 3 mistakes. There are differing errors rates for the same words per minute typed. As the words per minute increased the number of errors increased.

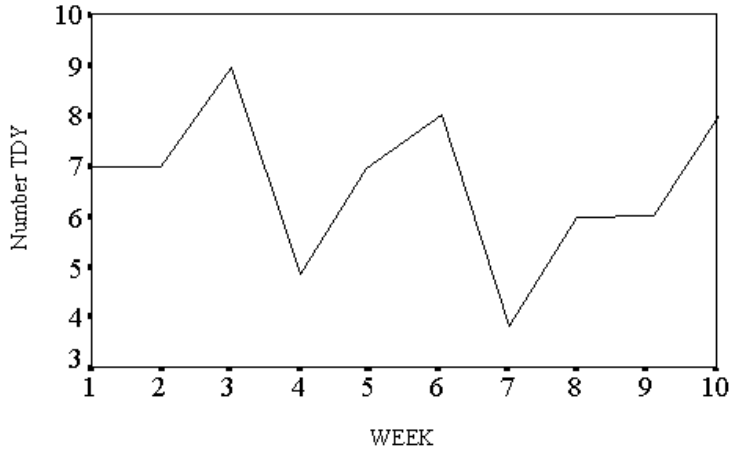
- Run Chart: To show changes in a process measurement over time, use a run chart. A run chart may also help recognize abnormal behavior in a process. Here's what to do:

    1. *Construct the chart.* Label the vertical axis with the key measurement of the process you want to measure. Label the horizontal axis with units of time.

    2. *Plot the data.* After collecting the data, plot each data point on the chart.

    3. *Interpret the chart.* One signal that shows the process has significantly changed: six steadily increasing or decreasing points in a row. Another possible signal: nine points in a row that are on the same side of the average.

Example: Here's an example of a run chart tracking the number of people who travel each week. It's important to recognize the variability inherent in any process. In this process, the variability is the number of people traveling (four to nine people). Take a look:




## List Possible Solutions to the Problem

By the time you get to this step in the sequence, you'll have most of the data the solution requires. As a part of this data, you'll have defined many of the criteria that will set the limits for the selection of the final solution. You're now ready to give your imagination free rein and list as many possible solutions as your facts and assumptions support. Each of the possible solutions must eventually be weighed against the criteria. As imagination could add a host of possible solutions to the above, let's explore creative thinking briefly.

**What is Creative Thinking?** According to Cronbach, creativity, or divergent thinking, is one's adeptness in making fresh observations and ideas. Creative thinking can be defined as the imaginative recombination of known elements into something new and different, in other words, the ability to see something in a new way. Since all ideas are syntheses of our experiences, we probably never have a truly original idea. We can, however, be creative by consciously changing and recombining old ideas or by improving or otherwise modifying established procedures.

**Barriers to Creativity.** Understanding the concept of creative thinking is only half of the battle, the other half centers on the barriers to the creative thought process. These barriers include:

1. Habit. This is lack of recognizing change is needed or reluctance to change from the old and accept new ways of doing things. (EX: "I wasn't aware that our current process was so inefficient," or "There's no need to change; we like doing it this way.")

2. Fear. This is fear of adopting new ways and fear of discarding old ways. This barrier also includes fear of authority and fear of being thought a fool for recommending the new or unusual. (EX: "It may be a good idea, but I'm not going to bring it up at a staff meeting in front of everyone.")

3. Inertia. This is resistance to change. This barrier includes a reverence for the traditional ways of doing things. It's demonstrated by a lack of desire to expend the energy necessary to effect a change. The difference between inertia and habit is this. When something is habitual, you don't recognize or acknowledge the need to change. On the other hand, you confront inertia when you know something needs to change, but you don't want to expend the energy to make that change happen. (EX: "We can't implement this new plan, we'd need to change all our slides and reference material.")

4. Prejudice. Viewed negatively, prejudice is unfounded hatred toward something. An impersonal example is distaste for modes of expression that differ from one's own. Viewed positively, prejudice is an unfounded affection, such as the preference for one's own opinion or pride of authorship. (EX: "The receiving section just wants us to change programs because they're better with Word. I'm going to stick with Word Perfect because I think it's the perfect word processing program.")

How can you overcome these barriers to creativity? The best way to begin is to develop a questioning attitude. Look at the situation and ask "why" until we get to the root cause of the barrier and confront it. To develop this attitude, we may work individually, using some form of interrogation method, or we may work as a group brainstorming a problem.

**Brainstorming.** Brainstorming is a group idea-generating technique designed to stimulate a chain reaction of ideas or possible solutions that relate to a stated problem. Since the basic purpose of brainstorming is to derive the maximum number of ideas and possible solutions, a brainstorming session should allow members of the

group to advance as many ideas and suggest as many solutions as possible without fear of criticism.

To get the best results from a brainstorming session, certain rules and procedures should be followed:

1. Quantity, Not Quality. Though quality is ultimately important, you should look for that quality in numbers--the more ideas your group generates, the greater your probability of finding viable solutions to the problem. If enough ideas are presented during a session, some will contain the quality needed, but the selection of the quality ideas must wait until the latter stages of the session.

2. Hitchhike Ideas. This is a way in which an idea rides in on another idea. In a brainstorming session, one member suggests an idea. This triggers a thought in the mind of another member. This continues until there is a whole series of ideas all prompted by an original idea.

3. Withhold Judgment**.** This means no evaluation, criticism (positive or negative), or judgment of any kind should be made of an idea advanced by a member of the group until the brainstorming is over. Evaluation and criticism will interfere with the flow of ideas.

4. Encourage Freewheeling. Freewheeling means that once the leader has the flow of ideas started, the leader allows the group to continue under its own steam with little or no guidance. He/she allows people to say whatever comes to mind; all ideas are accepted.

In addition to the rules of brainstorming we've covered, there are some techniques for conducting a brainstorming session that should be decided upon and implemented by the group. Since you may find yourself in the role of the group leader, we've listed some of these techniques: The group and/or group leader . . .

- selects a number of individuals to participate. The ideal size is 12 to 15 members.

- must limit the problem to an area the group knows something about.

- must state the problem and ensure each participant understands the problem.

- must appoint one or two recorders and instruct them to write down all ideas.

- should avoid placing a time limit on the brainstorming session.

The self-interrogation and brainstorming techniques we've discussed don't guarantee creativity. They are, however, excellent tools we can use to overcome the barriers to creativity during our problem solving process.

## Test Possible Solutions to the Problem

At this point in the sequence you put the possible solutions to a test. The yardstick you'll use to measure the effectiveness of these solutions will be the criteria the situation, your superiors, and you have established. The total criteria will come from your frame of reference, your goal, the nature of the obstacle, and from outside sources.

It's important to remember that each of the possible solutions must be tested against each of the criteria. If each final solution meets all criteria, what should you do? Decide on a final solution by deriving additional criteria against which to weigh these solutions.

## Select the Best Solution to the Problem

If in the previous step the solutions were tested and narrowed down to just one remaining solution, then that would be the best solution to the problem. If, however, there's more than one solution and each of these meets all the criteria, you must select the best solution from those remaining. We've already seen that this can only be done by establishing some additional criteria against which to measure each remaining solution.

Take, for example, the mower problem. We've worked through the process and found two solutions that meet all the criteria.

- Contract to have the mowers maintained by an individual for the amount of money remaining.

- Use off-duty personnel who are qualified in small motor repair to maintain the mowers for a minimum per hour wage rate.

We must now establish additional criteria against which to measure each of the solutions. The following are additional criteria you might consider. The selected solution should/must . . .

1. not interfere with the mission of any other organization.

2. if possible, contribute to the morale and welfare of all base personnel.

3. use military personnel in its execution.

4. be flexible enough to allow for alterations to assure you remain within the limits of the available funds.

With the criteria you chose, could you choose between the two remaining solutions? When you can, you've completed 90 percent of the problem-solving process. Your task isn't complete until you've **implemented the problem solution**.

## Implement the Problem Solution

As a junior officer, your superiors will hand you most of the problems you must solve. It'll then be up to you to select the best solution to the problem, prepare the necessary implementation procedures, and secure your superior's approval of both the solution and the procedures. For example, if you decided the best solution for the mower problem was to use off-duty personnel who are qualified in small motor repair to maintain mowers for a minimum per hour wage rate, you would need to submit a detailed report to the commander outlining the steps you went through in reaching the solution. Attach the necessary documents to implement the solution. Include, also, provisions for the commander to approve or disapprove the solution and implement instructions. The documents would include:

1. Notification in the form of letters to commanders or a notice placed in the daily bulletin to the effect that airmen are needed for this maintenance task.

2. Approval in the form of a letter to be signed by the support group commander to the effect that off-duty airmen can participate in this activity.

3. The necessary documentation required authorizing a building to be set aside and equipped for this activity.

4. A notice to the fire marshal of the potentially hazardous activity to take place in the shop to be established.

5. A notice to the accounting and disbursing officer authorizing him/her to pay the wages from appropriated funds as required.

6. A letter of authorization for the use of Air Force resources in this activity.

## Conclusion

You've just completed a detailed discussion of each step in the six-step problem solving process. During the resident portion of training, you will be expected to have an comprehensive understanding of the six-step problem solving process. You will also be expected to use this process to solve many of the problems confronting you during training. Learn these problem-solving steps for life application -- you will continue to use them throughout your trianing and your Air Force career.

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